TRANSLATION NO. 2215

DATE: April 1965

AD 675197

DDC AVAILABILITY NOTICE

Qualified requestors may obtain copies of this document from DDC.

This publication has been translated from the open literature and is available to the general public. Non-DOD agencies may purchase this publication from the Clearinghouse for Federal Scientific and Technical Information, U. S. Department of Commerce, Springfield, Va.

DEPARTMENT OF THE ARMY
Fort Detrick
Frederick, Maryland

BACTERICIDAL ACTIVITY OF PROPIOLACTONE FOG

/Following is the translation of an article by L. P. Mazurova and M. Ye. Martishin, Central Scientific-Research Disinfection Institute, Moscow, published in the Russian-language periodical Zhurnal Mikrobiologii, Epidemiologii i Immunobiologii (Journal of Microbiology, Epidemiology and Immunobiology) No. 10, 1966, pages 117-120. It was submitted on 28 March 1966. Translation performed by Sp/7 Charles T. Ostertag, Jr./

The native preparation of propiolactone corresponds to the foreign beta-propiolactone, which possesses a wide spectrum of virucidal, bactericidal and sporicidal activity (Hartman et al., 1955; Baxhinov and Kamorskiy, 1960; Ioffe and Osipyan, 1961; Pershin, et al., 1964).

Abroad, beta-propiolactone is used extensively for the sterilization of blood and its derivatives, for the preparation of vaccines, and for the disinfection of hospitals (Woodward and Clark, 1960).

At the Central Scientific-Research Disinfection Institute pripiolactone has been synthesized and a study made of its bactericidal, sporicidal and fungicidal activity in an aqueous solution and in an aerosol state (Katunina and Mazurova, 1961; Mazurova, 1963; Mazurova and Tsetlin, 1965). Pripiolactone in a vapor state is the most promising form of application as a disinfectant.

In connection with this, we studied the bactericidal activity of commercial propiolactone in the state of a monodisperse fog. The propiolactone was obtained from the "Reaktiv" Plant (Lvov). Its physical-chemical characteristics are as follows: Specific gravity 1.149, refractive index 1.412-1.413, percentage in preparation 97%.

The study of the bactericidal activity of the propiolactone fog was performed in an experimental chamber, 0.5 m^3 in volume, and in the isolation ward of the 10th building of the 14th Clinical Hospital imeni Botkina, where two isolation rooms were disinfected with propiolactone fog. The area of one of the rooms was 38 m^2, the other - 51 m^2, height 3.57 m.

The effectiveness of action of the propiolactone fog was determined on how it disinfected artificially infected test surfaces.

The test surfaces, simulating the surfaces under study, were plates, made of wood 10 · 10 cm^2 in size, some unpainted and some painted with oil paints, others covered with tile, linoleum, laminated plates for covering laboratory tables, tin plate, glass and plaster.

The artificial infection of the plates was carried out in a special infection chamber, 0.25 m^3 in volume. The plates were infected with aerosols of microorganisms which possessed a specific resistance to temperature and disinfectants. The bacterial aerosols were prepared from 24-hour broth cultures of E. coli, strain No. 1257, Staphylococcus aureus, strain No. 906, and a broth suspension of a 7-10 day culture of anthracoid spores, strain No. 96. The degree of infection per 1 cm^2 of surface was $4 \cdot 10^3$ for E. coli, $8 \cdot 10^4$ for Staphylococcus aureus, and $5 \cdot 10^4$ microorganisms for anthracoid spores.

For bringing the tests as close as possible to practical conditions, at the moment of infection and disinfection the test-surfaces were placed in various positions in the chambers and rooms. The test-surfaces were placed horizontally and vertically on the floor, and the plates made of plaster and glass were attached to the walls and ceiling. In each test 12 infected test-surfaces were disinfected.

One of the decisive moments in the bacteriological control of disinfection is the removal of the residual quantity of disinfectant during the inoculation of the test object or a washing on nutrient media. The disinfectant is either neutralized with the help of chemical substances (neutralizers) or, if a neutralizer is not known, is diluted to the minimum concentration which does not exert a harmful influence on a bacterial cell.

For propiolactone the neutralizer is sodium hyposulfite. The gauze tampon, which was used to take the washing from the infected surfaces after the influence of the propiolactone fog, was immersed in a test tube with an 1% solution of sodium hyposulfite. The tampon was stirred in the test tube and the liquid seeded on meat-peptone agar in a Petri dish.

It was not always possible to disinfect the surface of the accomodations from the aerosol cloud. Failures in disinfection are explained not only by the absence of effective preparations in a vapor state, but also by the fact that the majority of devices for the mechanical spraying form a polydisperse aerosol containing large sized droplets (400-1000 microns), which does not guarantee the uniform covering of the surfaces being treated.

Specially conducted investigations (Grishina and Pavlovskaya, 1965) showed that only with a high degree of aerosol dispersion on an order of 0.5-2 microns (in this case the weight median diameter is taken) is it possible to achieve a uniform covering of all the surfaces with the disinfectant fog. The deposit density of the preparation on the surface at this fog dispersity was 0.3-0.4 g/m^2.

We used sprayers for the laboratory and practical investigations which created a monodisperse aerosol. Droplet size was determined by the method of microscopic measurement of the projected diameter of particles, settled

on microscope slides covered with dimethyldichlorosilane, with the subsequent calculation of the diameters of free droplets. The dispersity of the aerosol was characterized by the weight median diameter (d_m in microns). The weight median diameter was found with the help of the integral curve of the weight distribution as the abscissa of a point having an ordinate equal to a half. The degree of polydispersity of the aerosol was evaluated based on the ratio of the average equivalent diameter to the average cubic (weight) diameter. The microscope slides, on which the particles were trapped, were situated in those places in the chambers and isolation rooms where the surfaces being subjected to disinfection were located.

For creating the propiolactone fog in the experimental chamber, we used a glass aerosol sprayer, which ejects the liquid with the help of compressed air from a compressor. The weight median diameter of the fog particles, created by the sprayer, was 1.3 microns, polydispersity - 1.02-1.4.

When selecting the aerosol generator for disinfecting isolation rooms or other accommodations at an infectious disease hospital, it is necessary to consider the necessity to obtain an aerosol with a high degree of dispersity in the shortest time possible. The generator should be portable so that it can be easily transported from one room to another. This requirement is met to the greatest degree by the chamber inhaler (KI-1), which is intended for the group therapy of patients by the method of inhaling medicinal aerosols. The KI-1 aerosol generator is regarded as a centrifugal sprayer. In the KI-1 the liquid is directed on the surface of a rapidly revoling disk (2825 rpm) and is split up into droplets. The weight median diameter of the particles, created by the generator, is 2.1-12 microns, polydispersity - 1.1-1.6. The height of the spraying jet is 1.3-1.4 meters. Output of the KI-1 is 19.2 ml/min. Servicing the generator is not complicated.

The relative humidity of the air during the period of the tests in the chamber and the isolation rooms was raised artificially up to 80%. The temperature in the chamber during the tests was $18 \pm 2^{\circ}$, in the isolated rooms - $9\text{-}12^{\circ}$.

The effectiveness of the propiolactone fog was studied at concentrations of 1.5; 3; 6; 12 g/m^3 and exposure times of 2, 5, 15 30 minutes and 1, 2, 4 and 6 hours.

For studying the bactericidal and sporicidal activity of propiolactone and mastering the disinfection rates which guarantee 100% death of the microorganisms, we set up 189 tests under laboratory conditions on the disinfection of 2368 surfaces.

E. coli turned out to be most sensitive to the propiolactone fog. The complete disinfection of surfaces, infected with E. coli, set in at a concentration of propiolactone of 1.5 g/m^3 and an exposure of 5 minutes. Staphylococcus aureus was considerably more resistant to the propiolactone fog; the complete disinfection of the surfaces took place at preparation concentrations of 6 g/m^3 and an exposure of 2 hours. The propiolactone fog was highly effective in respect to anthracoid spores. The spores died at preparation concentrations of 6 and 12 g/m^3 and exposures of 6 hours and 2 hours correspondingly. Analogous data were obtained when hospital isolation rooms, infected with vegetative forms of microorganisms, were treated with propiolactone fog. In the event of contamination with spore forms of microorganisms, for the destruction of the spores it was necessary to increase the exposure from 2 to 6 hours with the same concentration of propiolactone - 12 g/m^3.

During the disinfection of isolation rooms the activity of the propiolactone fog was noted in respect to the natural aeroplankton of hospital isolation rooms. Air samples were taken with a Krotov device at a rate of 30 liters/min for 3 minutes. At a concentration of 6 g/m^3 and exposure of 2 hours the propiolactone fog caused the death of 98% of the aeroplankton. When the concentration of the preparation was doubled (12 g/m^3), with the same exposure time the propiolactone fog completely destroyed the bacterial aeroplankton.

Conclusions

1. Commercially synthesized propiolactone fog possesses high bactericidal and sporicidal properties.

2. For creating a propiolactone fog under practical conditions it is possible to use the KI-1 sprayer, which creates an aerosol with a high degree of dispersity.

3. Propiolactone fog may be used for the disinfection of isolation rooms and other isolation accomodations in an infectious disease hospital when its profile is being changed. The expenditure of preparation for these purposes should be 6 g/m^3 with an exposure time of 2 hours. When disinfecting objects infected with spore forms the preparation should be used in a concentration of 12 g/m^3 and an exposure time of 6 hours.

Literature

1. Bazhinov, A.G., Kamorskiy, N.M., Zh. mikrobiol., 1960, No. 7, p 26.

2. Ioffe, I.S., Osipyan, V.T., Voyen. med. zh., 1961, No. 6, p 52.

3. Katunina, V.I., Mazurova, L.P., Trudy Tsentralnogo nauchno-issled. desinfektsionnogo in-ta., 1961, No. 14, p 114.

4. Mazurova, L.P., Ibid., 1963, No. 16, p 38.

5. Mazurova, L.P., Tsetlin, V.M., Ibid., 1965, No. 17, p 116.

6. Pershin, G.N., Belikov, G.P., Danielyan, N.M., et al., Zh. mikrobiol., 1964, No. 3, p 109.

7. Hartman, F.W., Kelly, A.R., Logrippo, G.A., Gastroenterology, 1955, v 28, p 244.

8. Woodward, M.F., Clark, A.B., U.S. armed Forces med. J., 1960, v 11, p 459.